Design Considerations for Trust in situated Human-Robot Interaction

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1 Problem Statement

Active and Assisted Living (AAL) technologies like robots are increasingly promoted for the care of older people at home. However, using these technologies in private spaces may come with issues of trust. Research also suggests that older adults use a language of distrust to refer to digitalization in a Western society as a whole (e.g. Knowles and Hanson, 2018), and this may be also responsible for a limited uptake of technology by people (Haslwanter and Fitzpatrick, 2017).

In Human-Robobt Interaction (HRI) however, multiple perspectives can be taken for trust (e.g. Mayer et al., 1995; Lewis and Weigert, 1985). Empirical work has predominantly taken a reductionist approach, targeting trust as a variable in controlled experiments (Zafari et al., 2019; Rossi et al., 2017). To complement previous research and to design for real-world settings, we see an opportunity in gaining a better understanding of people's needs in their everyday lives. Research in Computer-Supported Cooperative Work (CSCW) has been at the forefront of studying collaborative care engagements (Fitzpatrick and Ellingsen, 2013), also taking into account a more situated understanding of people's practices (Kuutti and Bannon, 2014). While CSCW does not focus on robots, it will be potentially useful to learn from current approaches to studying trust in collaborative ensembles.

While several studies on trust have been conducted with younger participants and robots in controlled settings, these have focused on dyadic human-robot

interactions. We see an opportunity in complementing this research with a bottom-up understanding of trust in relation to HRI and also taking into account perspectives of multiple stakeholders and their practices. Practice-oriented work explores "*[...] historical processes [..], longer-term actions which persist over time, and which must be studied along the full length of their temporal trajectory[,][...], situated in time and space*" (p. 3534 Kuutti and Bannon, 2014). A practice lens also requires us to look at interaction sites and usage of current technologies (Wulf et al., 2011).

Exploring methods to capture factors that influence trust in relation to HRI will also provide an opportunity to gain a better understanding of day-to-day practices, where recent work has also called for methods to design and evaluate robots (Werner et al., 2015). Given robots are complex to develop and changing them later will be costly, recent work has suggested participatory design for robots (Lee et al., 2017). This approach however involves stakeholders from multiple disciplines (Lan Hing Ting et al., 2018) (e.g., gerontologists, social scientists, engineers). To make collaboration in these teams more effective, we see an opportunity in considering the challenges for method exploration, e.g., concerning knowledge transfer (Vincze et al., 2014).

2   Research Questions

The aim of this thesis is to answer the question,

RQ: *How to design for trust in situated human-robot interaction in older adults' living spaces?*

To answer this main question, several sub-questions need attention:

RQ1: What can HRI learn from studying trust in related research areas, i.e., from CSCW taking into account practice-based research, and what are the limitations of typical experimental HRI studies?

RQ2: What can we learn about trust from older adults' current practices and their use of AAL technologies for designing robots?

RQ3: How can we capture trust methodologically, both taking into account interdisciplinary teams in participatory design and older people's social practices in real-world settings?

3   Methodological Approach

The overall aim of this thesis is to develop and present design considerations for trust in situated human-robot interaction. RQ1-RQ3 will be answered taking a constructivist worldview and using predominantly qualitative methods in several case studies.

RQ1. On a theoretical level, a critical literature overview is needed on trust in HRI and in related areas, i.e., CSCW, where the situatedness of interactions has been taken into account for some time (Kuutti and Bannon, 2014; Wulf et al., 2011; Fitzpatrick et al., 2015). The aim of this narrative review is to explore what CSCW can contribute to an understanding of trust in situated HRI. To illustrate how trust has been worked on in HRI, we will also conduct a pilot study with 27 participants on how robot-related design cues (i.e., relationship strategies) can affect people's trust. This will be followed by a methodological discussion.

RQ2. A nuanced understanding of older adults' current practices and long-term usage of current technologies is needed to understand older adults' values and to provide lessons-learned for designing robots in this context. Therefore, we will on one hand provide findings on trust from using our novel method using elicitation cards (also used to answer RQ3). This will yield an understanding of older adults' current practices and topics related to trust that are particularly relevant in the context of envisioning robots in people's living spaces.

As a next step, we will conduct a long-term study with older adults using current AAL technologies. This will be useful to understand how technology is currently embedded in complex relationships in people's everyday spaces, where an understanding of qualities of these relationships will be useful to provide lessons-learned for a better understanding of situated trust taking a more holistic unit of analysis. In our study, several devices tailored to older adults (including tablets, fall detection sensors, safety watches) will be deployed to over 80 households for over 18 months. We will conduct 20 qualitative interviews with 15 older adults in two phases. The study will be also useful to unpack factors that influence trust in relation to robots that are not yet commonly in use.

RQ3. Because we lack an understanding of factors that affect trust, we also lack methods to study these. To gain an initial understanding of current challenges of participatory design with older adults and robots, we will conduct workshops with 17 older adults and commercially available robots. While these workshops will complement previous participatory design research in HRI (Lee et al., 2017), we will also reflect on challenges related to interdisciplinary collaboration. As a next step, we will iteratively develop a deck of elicitation cards to be used in qualitative interviews on trust in situated HRI. As part of this study, 10 people with little experience in qualitative research will be involved in designing and testing the method, and it will be used with additional 10 older adults.

4   Findings to Date

4.1   RQ1: Trust in HRI and HCI/CSCW

Our critical literature review shows how trust has been worked on differently across the fields of HRI and HCI/CSCW and present gaps (Schwaninger et al., 2019). Most HRI studies on trust focus on dyadic interactions between one person and one robot (Martelaro et al., 2016; van Straten et al., 2018). In contrast, trust in HCI/CSCW

has been studied mainly between people (Robert, 2016; Lampinen et al., 2016) and in institutions (Corbett and Le Dantec, 2018). Further, technology is often seen as interwoven with broader social contexts of people's everyday lives in HCI/CSCW, which has not been the case in HRI. Looking at people's practices may be however fruitful for trust, as interactions with robots will be interwoven with those practices.

To illustrate how trust has been predominantly worked on in HRI using social robots, we also performed a pilot study on how a robot's language cues can affect people's trust in a controlled setting. We conducted a user study, where we evaluated the effect of different interaction styles on people's trust (Zafari et al., 2019). The findings of our pilot study suggest that a robot's verbal cues and relationship strategies can potentially have an effect on trust.

4.2 RQ2: Learning from People's current Practices

We conducted a study using our deck of elicitation cards as described in the next subsection. Salient trust-related themes that were identified from the analysis of card usage were the desire for control, companionship, privacy, understandability, and location-specific requirements with regards to trust. Further, older adults had different privacy preferences throughout their homes, and different acceptance of a robot's capabilities, which they realized throughout the conversations.

A second study was conducted as part of a large-scale AAL project with older adults using current AAL technologies. Drawing on 20 qualitative interviews with older adults, we identified different forms of relatedness (Ryan and Deci, 2017) in these complex ecosystems, such as between older adults and people, technology, places, and institutions (Schwaninger et al., 2020).

4.3 RQ3: Methodological Insights and Method-Development

To gain an initial understanding of methodological challenges of participatory design with older adults and robots, we conducted three participatory design workshops with older adults and three prototypes of voice assistants. In the workshop itself, the voice assistants were perceived not useful by participants as they were presented to interact with verbally. Our reflection on the workshop points to challenges when organizing workshops with older adults as interdisciplinary teams, i.e., in relation to researchers roles, participant recruitment - in particular terminology and expectations -, and robot design. Using the term 'robot' when recruiting participants yielded specific expectations, and we found that using this term with caution would be beneficial in the future.

To offer a methodological contribution related to trust, we developed and tested a deck of elicitation cards to facilitate conversations about trust at early stages of participatory design. The deck of cards was designed together with 10 Informatics students as exemplars of engineers working in interdisciplinary research teams, which yielded several card categories to be used in qualitative interviews. Because trust is an abstract topic, the cards also use elicitation techniques. When using the

cards in 10 interviews with older adults, they acted as ice-breakers and helped to establish trust. The findings have been written up as an article and were accepted for a Special Issue in the International Journal of Social Robotics.

5   Next Steps

To develop and present design considerations, it will be necessary to further specify the contribution of this thesis. It will be also important to synthesize across all findings and to develop and present perspectives for design from across theoretical work and empirical studies.

Concerning design, several points may be considered for discussion. Methodological reflections will be presented to engage with older adults and robots, e.g., in relation to expectation management and terminology. An understanding of older people's practices and values will also be helpful to develop design considerations based on factors that influence trust in these real-world settings. This will concern aspects like a holistic unit of analysis, older adults' values and individual differences, and topics related to trust to consider specifically when designing for older adults. Potentially, concrete use case scenarios with robots can be presented as well. While several publications have been associated with this thesis, we are also in the process of writing and planning further publications. We are currently in the process of writing a journal article in a collaboration based on the data on a long-term AAL project. Further, we have been collecting data at a care home in a collaboration, which will feed into publications and which we may draw on to outline future work in this thesis.

6   Expected Contributions

The aim of this thesis is to present design considerations for trust in situated human-robot interaction, being the main contribution. Building blocks include findings from the literature, an understanding of older people's values and topics that affect trust from the field, methodological findings, and perspectives for design. The theoretical part will be pull together findings on how to approach trust from the literature across HRI and CSCW. Drawing on several case studies with older adults, we will present topics that affect trust and a nuanced understanding of relational qualities in (care) ecosystems. Methodological findings will be based on exploring participatory design approaches for robots with older adults in multidisciplinary teams. A broad set of design considerations will be presented based on findings from the literature, investigations in the field, and methodological lessons-learned.

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